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Abstract

PROBLEMS IN THE DESIGN AND CONSTRUCTION OF LARGE REACTOR VESSELS

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Reactor vessels for pressurized and boiling water system nuclear power plants of 500 to 600 MWe capacity are now under construction in the United States. Designs are being finalized for reactor vessels for 1000 MWe plants, with studies being made of vessels for plants up to 1500 MWe capacity. The relation between power plant size and reactor pressure vessel size is shown for the pressurized water (2500 psi design) and boiling water (1250 psi design) nuclear power systems.

The philosophy of pressure vessel design for nuclear applications is being changed. Sections I and VIII of the ASME Code required the pressure vessels to be sized on the "maximum stress theory". The new philosophy of Section III of the Code utilizes the "maximum shear stress theory". The reason for the change in philosophy and the effect of this change on the designs for large reactor vessels is discussed.

A reactor vessel for a 1000 MWe pressurized water plant designed to Section I or VIII of the ASME Code would require plate materials of about 14 in. in thickness. The vessel flange would be 230 in. in outside diameter and about 18 in. thick. A reactor vessel for a 1000 MWe boiling water plant designed to the same Code requirements would require plate materials of about 9 in. in thickness. The vessel flange would be 292 in. in outside diameter and about

15 in. thick. The problem in detailing the design of large vessels so that quality materials may be purchased for fabrication are discussed. The various grades of Code-acceptable steels are compared from economic and design standpoints for use in reactor pressure vessels.

The problems in inspection of these materials to determine that the quality meets the unique requirements for this application are described. The investigation of radiation damage to reactor vessel materials is not included in this paper. The effect of acceptance of high-strength steels, produced by quenching and tempering heat treatments, on the designs is presented together with a delineation of the problems associated with low cycle fatigue loadings.

The evolution of fabricating techniques for large, heavy vessels is reviewed. The space and handling problems presented by the increased use of reactor vessels of 15 to 22 feet in diameter, weighing up to 800 tons, is discussed. Plant siting requirements are stipulated to enable complete shop fabrication, testing, and shipment of these reactor vessels. The time required from order date to delivery is forecasted for the range of reactor vessels required by nuclear power plants of up to 1500 MWe.